

DIVERTICULA OF THE ŒSOPHAGUS.

WITH THE REPORT OF A CASE.

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THE term diverticulum is properly applied only to a circumscribed pouch-like protrusion or bulging involving a limited part of the circumference of the œsophagus, and should not include sacculated dilatation of the whole tube that occurs above strictures or from paralysis of its muscular wall. Neither should abscess cavities communicating with the lumen by fistulous tracts, nor defects in the wall from ulceration and cicatrization, which permit of slight sacculation of the œsophagus, be included under this head. The characteristic features of a true diverticulum are that they are sharply defined; pouch-like protrusions of the œsophageal wall, lined with a normal or but slightly altered mucous membrane. Ulceration of the inner surface of the pouch is but rarely found. As a result of long-continued irritation from imprisoned foreign matter, degenerative changes with papillary or carcinomatous outgrowths sometimes occur.

As there is no sharp line of demarcation between the pharynx and the œsophagus, it would not be possible to consider diverticula of the œsophagus without discussing those of the pharynx. Among the cases reported in the older literature, many that would now be classed as pharyngeal were described as belonging to the œsophagus. This was in part due to the inaccuracy of the observer, and in part to the uncertainty as to what constitutes the lower limits of the pharynx. Again, by far the greater number of diverticula have their point of origin at the junction of the pharynx and œsophagus, and may with propriety be considered as belonging to both.

The difficulty in determining whether these border-line cases properly belonged to the pharynx or œsophagus led Starck to group them as pharyngo-œsophageal, and Rosenthal as "Grenz" diverticula. The anatomical landmarks by which the pharyngo-œsophageal junction may be determined are still a matter of dispute. The older writers were satisfied to consider the point at which the respiratory and alimentary tracts became distinct as indicating the beginning of the œsophagus. Others consider that the characteristic arrangement of the musculature, the inner circular and the external longitudinal layers, indicate the termination of the pharynx and the beginning of the œsophagus. By some the smallest part of the tube is considered the point of division. At the present time, most writers fix the upper limit of the œsophagus at a point corresponding to the lower border of the cricoid cartilage. As all of these are subject to considerable variation, it is therefore difficult, excepting after the most painstaking investigation, to determine the starting-point of some diverticula. For all practical purposes, the pharyngo-œsophageal junction may be considered as on a level with the lower border of the cricoid cartilage. This point will also in most cases mark the narrowest part of the tube. In children the upper limit of the œsophagus is slightly above this, while in the aged the œsophagus may be dragged down so that it is considerably below the cricoid cartilage.

The history of diverticula of the œsophagus dates from the publication of a paper by Mondiere,¹ in which we find the first accurate description of this condition.

Following this publication, Rokitsansky, in 1840, classified them from an etiological stand-point into two groups. First, those that are due to traction from without exerted upon a portion of the œsophageal wall; and, second, those that result from pressure from within. The first group he called traction and the second pulsion or pressure diverticula. This classification has been followed by all writers since his time, and his work, dealing mostly with the first group, has up to the present time constituted our chief source of knowledge of traction diverticula. Zenker² was the next to bring this subject into promi-

nence. His contribution, based upon the study of thirty-four cases, of which twenty-two had come to autopsy, constitutes a fountain from which all subsequent writers have freely drawn. In this masterly work we find the first careful study of the pathogenesis and symptomatology and clinical significance of pressure diverticula.

Since the publication of Zenker's work many contributions to this subject have appeared. The most important of these are the theses of Oekonomides,³ Starck,⁴ and Rosenthal.⁵ The latter is by far the most complete contribution to this subject that has appeared since Zenker's work was given to the profession.

Following the classification of Rokitansky, Zenker described but two groups: Traction and pressure diverticula. A third distinct and important group has been added by Oekonomides,—the traction-pressure diverticula. In this form we have a traction diverticulum enlarged by pressure from food accumulating within its cavity, causing it to acquire a pathologic importance equal to the pressure diverticulum described by Zenker.

Little importance is ascribed by Rokitansky, Zenker, and their followers to traction diverticula. In most cases they seem to cause no symptoms during life by which they can be recognized, and are only rarely found post-mortem. A more careful examination of the œsophagus would undoubtedly show them to be more common than the autopsy reports of the past would indicate. Traction diverticula are generally the result of traction made by the shrinkage of scar tissue that is attached to the œsophagus. The contraction commonly follows an inflammation originating in a bronchial lymph gland at or near the bifurcation of the trachea. It may also be the result of an inflammation spreading from the pleura or pericardium to the œsophagus and its surrounding areolar tissue, or through the pleuro-œsophageal muscle of Hyrtl. This mode of origin explains their situation on the anterior wall of the œsophagus, and also their frequency in children and in tubercular subjects. They are generally small funnel-shaped recesses, having for

their wall either all of the tunics of the œsophagus or its mucous membrane alone. Their direction is, according to Zenker, mostly horizontal or oblique, with the orifice of the pouch directed downward. The direction of the lumen of the sac, with the slight chance afforded for arrest and retention of food particles, explains the absence of the clinical symptoms common in pressure diverticula.

In a case reported by Chiari,⁶ a traction diverticulum developed from contraction of the scar tissue connecting a degenerated goitre with the œsophagus. A few cases undoubtedly have been observed where no scar tissue or evidence of an antecedent inflammation could be demonstrated. These are to be explained by the presence of the tracheo-œsophageal and pleuro-œsophageal muscle, that binds together the œsophagus and trachea and the œsophagus and pleura. The presence of this muscle with unequal displacement of the trachea and œsophagus could, by producing traction upon the œsophagus, cause a diverticulum at its point of attachment. Inflammatory processes, spreading from the trachea, bronchi, or the pleura, to these muscles, may also from subsequent contraction be the cause of a diverticulum, as was shown by two specimens examined in serial sections by Riebold.⁷ Although traction diverticula are generally regarded as of slight importance, they may by perforation of the diverticular wall become a serious menace to life. Rokitsansky recognized this danger, and reported a fatal case of perforation of a diverticulum. When perforation occurs, it is either from a sharp foreign body lodged within or through ulceration from pressure or retained food. A case is reported by Coester,⁸ where the sac was penetrated by a sharp spicule of bone which entered the vena cava and caused a fatal hæmorrhage. Other cases are reported in which the aorta and vena cava have been injured by sharp bodies lodged in a diverticulum. Zenker reports two cases, one of his own and one of Merkle's, in which sudden death was caused by penetration of the pulmonary artery by sharp pieces of bone that had lodged in a traction diverticulum. Death may also be the result of perforation of a diverticulum with subsequent infec-

tion of the mediastinum, pleura, or pericardium. In fact, when death results from the presence of a traction diverticulum, it is generally from infection of the mediastinum or from a gangrenous pneumonia. Occasionally a bronchus is perforated, causing a fatal septic bronchitis. Zenker mentions a case of a woman sixty-six years of age who died of an obscure disease. The autopsy revealed a double gangrenous pneumonia, with a perforation of the right bronchus, communicating with an abscess of the mediastinum, into which, on the opposite side, opened the diverticulum of the œsophagus.

Aside from the dangers incident to perforation of a traction diverticulum, in a few cases they become of great clinical importance by being converted into pressure diverticula from the arrest of food particles and the consequent distention of the sac from pressure and traction. This occurred in eight of 133 cases of traction diverticulum, according to Rosenthal. To this group Oekonomides has given the name of traction-pulsion diverticula. They are situated, as are traction diverticula, on the anterior wall of the œsophagus, and generally near the bifurcation of the trachea. Unlike the latter, however, they are of the greatest clinical importance, and give rise to symptoms quite as distinct, when of the same size, as those that are primarily caused by pressure. Of this group Rosenthal was able to find nine cases reported in the literature, the first being by Tiedemann, in 1875. In three of these the sac was of large size, from four to seven centimetres in depth, and pear- or egg-shaped, resembling in structure pulsion diverticula. In one (Tetanus^o) the orifice of the sac was three and one-half centimetres below the cricoid cartilage, and in a second the fundus was found the same distance above the cardia.

Traction diverticula which are always of small size cause no symptoms during life by which they may be recognized. Difficulty or delay in swallowing granular foods, such as rice or corn, may be sufficient to attract attention, according to Tiedemann.¹⁰ If the sac causes the arrest of food, it soon becomes enlarged, and is then a traction-pulsion diverticulum with the symptoms in the main of a pulsion diverticulum. Dys-

phagia, however, has not been an early symptom in the cases reported. In the case of Scherpenburg,¹¹ pressure of the sac upon the left subclavian produced a change in the volume of the left radial pulse. Regurgitation, vomiting, dyspnoea, and pain from pressure when the diverticulum is filled are symptoms common to this group and to pressure diverticula. Death from inanition is almost a constant termination in traction-pulsion diverticula. Relief from surgical procedures is impossible on account of the deep location of the sac.

Pressure or pulsion diverticula, unlike those caused by traction, always produce symptoms by which they may be recognized during life. Although not so common as the latter, they are of far greater interest to the practitioner. First, because of the difficulty encountered in making a correct diagnosis, and, second, because the condition, if not relieved by surgical means, will ultimately destroy the life of the patient. Of the twenty-seven cases reported by Zenker, in which the diagnosis was verified by autopsy, thirteen died from starvation and eight from intercurrent diseases, superinduced by the diverticulum. In six the cause of death was not mentioned in the report.

For convenience of description, and because of the difference in the clinical importance, mode of development, and variation in the symptoms produced, pressure diverticula may be grouped into

1. Those of the pharynx proper.
2. Those at the pharyngo-oesophageal junction, the borderline cases, or Grenz diverticula of Rosenthal.
3. Diverticula having their origin in the middle third of the oesophagus somewhere near the bifurcation of the trachea, and mostly just above the left bronchus. This is the epibronchial group of Leutgert.¹²
4. The deep-seated diverticula; those in which the origin is below the level of the left bronchus, with fundus a variable distance above, but usually near, the diaphragm. These have been termed epiphrenal diverticula, because most of them are given off from the oesophagus a short distance above the dia-

phragm with the fundus of the pouch resting upon it. These diverticula of the first group are found mostly on the lateral wall of the pharynx and rarely on the posterior median aspect, as are those of the pharyngo-œsophageal junction. Most lateral pharyngeal diverticula are congenital, probably originating from the remains of the third and fourth branchial clefts, the starting-point being an incomplete internal branchial fistula that has from pressure from within gradually dilated and assumed the characteristic shape of a diverticulum. Koenig and Es-march considered this to be the mode of origin of all diverticula of the pharynx and also of the pharyngo-œsophageal region. While the possibility of an internal fistula offers a plausible explanation of the first group, it must be admitted that it has never been conclusively demonstrated by dissection. In these cases in which the symptoms of a diverticulum date from early childhood, it is possible that the presence of a congenital defect will explain their early onset. This defect may be either an internal branchial fistula or a congenital pouch-like recess in the postero-lateral pharyngeal wall, such as occur normally in certain lower animals; *e.g.*, the pig, camel, and elephant. Congenital stenosis of the œsophagus may also be the cause of the early symptoms, and may be an important factor in causation of a diverticulum.

In the case reported by Heusenger,¹³ in which the symptoms began in early childhood, the position of the sac would make it appear as if the diverticulum originated in a branchial fistula. In this case the patient, a man aged sixty-seven years, had suffered from earliest childhood from dysphagia and regurgitation of food. On examination, no difficulty was found in passing a sound into the stomach. The finger could be passed into a sac which lay to the right of the base of the tongue, and which contained a large quantity of mucus and remains of food taken some days before. By pressure upon the lateral walls of the pharynx, the pouch could be emptied. Another case similar to this in which the symptoms began in early life is reported by Bartelt.¹⁴ This case, although reported as a diverticulum of the œsophagus, probably was of pharyngeal origin.

Trauma, causing a weakening or rupture of the muscular wall of the pharynx, may be an important factor in the development of a diverticulum. In the case reported by Klose and Paul,¹⁵ injury to the pharynx by a fish-bone which lodged in the throat was considered by them to be the cause of the diverticulum. In this case the fundus of the sac lay four centimetres under the isthmus of the fauces on a level with the cricoid cartilage. The orifice was one and one-half inches higher behind the isthmus. The capacity of the diverticulum was about four drachms. Although the symptoms characteristic of a diverticulum dated from the time of injury in this case, their relation to the accident might be explained by assuming that a diverticulum or a congenital malformation existed at the time, and that the foreign body lodged within the cavity had first directed attention to its presence.

Excessive pressure within the pharynx from long-continued blowing on wind instruments, or from shouting, may, in case the pharyngeal wall is weakened from previous disease, cause a dilatation of a part of the pharynx that later, from accumulation of food, becomes a diverticulum. In others the pressure may cause a separation of the fibres of the pharyngeal muscles, and a hernia of the mucous membrane may result, which subsequently, from retention of food, may become a pulsion diverticulum. In a case reported by Wheeler,¹⁶ an officer, after an attack of erysipelas which involved the throat, gradually developed a tumor on the right side of the neck under the sternomastoid muscle, which increased in size when the pressure within the pharynx was increased, as in shouting. The voice was hoarse and uneven, and cough was troublesome. The patient was operated upon, and the sac, which was of mucous membrane alone and which pressed upon the right recurrent laryngeal nerve, was excised and the pharynx closed. Recovery with complete control of the voice followed.

The symptoms occasioned by lateral pharyngeal are on the whole similar to those of pulsion diverticula of the œsophagus. Dysphagia, however, is not so constant nor so troublesome as in the latter. Cough and dyspnoea from the contents of the

sac escaping into the air-passages, and from pressure upon the larynx, or upon the recurrent laryngeal nerve, have been the most characteristic symptoms in the cases reported. As a rule, the diverticulum does not obstruct the œsophagus to any considerable degree, and therefore the patient does not suffer from inanition, as in œsophageal diverticula.

Pharyngo-œsophageal pulsion diverticula are the most common as well as the most important from a pathologic and clinical stand-point. The etiology of many is yet unsolved. They develop exclusively in the median line posteriorly. At times from traction, as the sac grows larger and is compressed against the vertebral column, they are dragged to one side, usually to the left, the fundus being in relation to the lateral wall of the œsophagus. In the course of development of the pouch, the œsophagus is also displaced, so that the axis of the pharynx and the orifice of the diverticulum are in a line, permitting easy entrance of food into the sac and obstructing the lumen of the œsophagus. Their point of origin corresponds to a triangular space just below the inferior constrictor, where, by the separation of the longitudinal muscular bands of the œsophagus and the absence of circular muscular fibres, there is normally a defect in the muscular wall of the œsophagus. This point of least resistance in the œsophagus has been called the Lainer-Hackermann¹⁷ point. It is here that the separation of the muscular fibres takes place with the greatest ease. Above this the interlacing fibres of the superior constrictor and below the circular, inner, and the longitudinal outer muscular layers are capable of withstanding pressure from within. At this point the œsophagus is also narrowest and fixed in front by its relation to the cartilaginous larynx, so that any increase in pressure within its lumen must unequally distend its posterior wall. In case of arrest of an unusually large bolus of food or of a foreign body, it is this weak point that bears the impact. It is thus readily seen that a foreign body lodged here may separate the muscular fibres and produce a hernia of the mucous membrane, which later develops into a diverticulum. A number of cases are reported where the symptoms of a diverticulum followed close

upon the arrest of a foreign body, such as a piece of bone, in this part of the œsophagus. Aside from injuries from ingestion of large masses of food or a hard foreign substance, it is possible for lesions of the muscular wall of the œsophagus from trauma from without to be the immediate cause of diverticulum. A case of this kind is reported by Freiberg.¹⁸ The patient, an officer, was thrown from his horse during some military manoeuvres and sustained an injury to the head, from which he remained unconscious for twenty-four hours. After regaining consciousness, a swelling was observed between the trachea and the sternomastoid muscle. He immediately complained of dysphagia, which gradually increased with the onset of other symptoms of a diverticulum, although the swelling disappeared. The symptoms of obstruction continued until death from inanition took place. As a result of the accident, a laceration of the wall of the œsophagus had occurred, which was immediately followed by the development of a pressure diverticulum.

A case similar to Freiberg's has recently been reported by Schlesinger.¹⁹ In this the patient, a male of sixty-seven years, fell from a scaffolding fifteen years before he presented himself for examination. Immediately after the accident he experienced difficulty in swallowing, which later became serious. Œsophagoscopic examination showed the sac twenty-three centimetres from the incisor teeth. Measurements of the contents of the sac showed its capacity approximately 250 centimetres. The patient subsequently died from an acute pneumonia. Autopsy showed that the diverticulum had its origin at the pharyngo-œsophageal junction, and that its orifice was dragged downward two and one-half centimetres below the cricoid cartilage, and was seventeen and one-half centimetres from the line of the teeth. The sac measured six centimetres in both its vertical and transverse diameters. Its inner surface was somewhat eroded, and at one point a small warty excrescence was found, which, on histologic examination, proved to be carcinoma. Schlesinger considers that the fall caused a rupture of the œsophagus. This view is supported by the occurrence of a slight hæmorrhage at the time of the injury.

Cicatricial stricture of the œsophagus, although but rarely associated with diverticula, yet occasionally bears a causal relation to this condition, as is shown by a few recorded cases. One of this kind is reported by Nicoladoni.²⁰ A child of eight had two years before swallowed a solution of caustic soda which caused a stenosis of the œsophagus. Shortly afterwards the characteristic symptoms of a diverticulum developed. To permit feeding, the œsophagus was opened by lateral incision and a tube introduced into the stomach. The patient died eight days later of bronchopneumonia. The autopsy showed a cicatricial stricture of the œsophagus just below the cricoid cartilage. Immediately above the stricture the œsophagus was dilated, and from the posterior lateral wall a typical diverticulum was given off. A similar case was reported by Braun.²¹

Congenital strictures of the œsophagus when found are often situated at the upper limit of the œsophagus. When the symptoms of a diverticulum of this region date from early childhood, the presence of a congenital narrowing of the œsophagus offers the most rational explanation of their origin. An interesting case of a diverticulum that was situated immediately above a non-traumatic stricture is reported by Richardson.²² In this a typical pulsion diverticulum, the size of a hen's egg, was found above a stricture of the upper part of the œsophagus, that had narrowed its lumen until it had the diameter of a lead-pencil. The mucous membrane appeared thickened and granular, but showed no scar tissue nor ulceration. The muscular wall of the œsophagus at the site of the stricture remained unchanged. The normal character of the tissue at the point of stricture would point to a congenital origin. Cases in which a diverticulum was found above a congenital stricture, and which from the description would appear to be similar to Richardson's case, are reported by Cassan²³ and by Bauernfeind.²⁴ In the latter a stricture that admitted a sound only six millimetres in diameter was found at the level of the first tracheal ring. The absence of scar tissue and infiltration proved it to be of other than inflammatory origin. Above this constriction a sharply defined sacculaton, three and one-half centimetres deep,

was found. In Cassan's case difficulty in swallowing dated from early childhood. This, with the absence of cicatricial tissue, proved the stricture to be congenital.

Diverticula situated between the pharyngo-oesophageal junction and the upper border of the sternum are rare, and are probably all of the traction-pulsion group, which have already been considered. Below this, at the level of the left bronchus, there occur occasionally diverticula which are etiologically distinct from the pulsion diverticula of Zenker. These are the epibronchial diverticula of Leutgert. He considers that the anatomical relations of the oesophagus and left bronchus at this point explain their origin, and also determine the frequency of the development of carcinoma in this part of the oesophagus. On examining the oesophagus when removed with the lungs and bronchi intact, Leutgert found that the left bronchus, where it crossed the oesophagus, caused a distinct bulging-in of the anterior oesophageal wall. Above this there is a more or less distinct recess, varying in different specimens from a slight depression to a pocket deep enough to contain the tip of the index-finger. In children this was not found. He believes the obstruction caused by the left bronchus to be sufficient to temporarily arrest the food, which, under certain conditions, such as the presence of an abnormally large bolus, may deepen this epibronchial pocket, and thus cause a diverticulum.

Diverticula of the lower third of the oesophagus are mostly situated just above the diaphragm, and for this reason have been termed epiphrenal. The etiology of this group is not yet clear. Some of them at least are traction-pulsion diverticula, although there are but few glands in close relation to this part of the oesophagus. In the cases reported, the diverticula were mostly found given off from the lateral or anterior wall of the oesophagus, differing in this respect from those higher up. Tetans describes a case in which the fundus of the sac reached to within a few centimetres of the cardia. In the neighborhood of the diverticulum were found pigmented lymph glands, but no cicatricial tissue connecting them with the diverticulum. He regards the diverticulum as belonging to the traction-pulsion

group. A deep-seated diverticulum of the anterior wall of the œsophagus is described by Oekonomides. At the autopsy of a woman who died at the age of eighty-three, a diverticulum the size of a small apple was found, eight and one-half centimetres above the cardia, anterior and somewhat to the right of the œsophagus. The sac contained no muscular fibres, and was lined with normal mucous membrane. The absence of fibrous tissue or degenerated glands led to the belief that this was primarily a pressure diverticulum. No explanation of its origin was given.

Besides the traction-pulsion diverticula of the lower part of the œsophagus, there are a few that are probably due to a constriction of the œsophagus at a point where it passes through the diaphragm. This constriction may be a cicatricial stenosis of the œsophagus, or may be due to a congenitally narrow opening in the diaphragm.

The appearance of a typical pressure diverticulum, as found at the pharyngo-œsophageal junction, is that of a sharply defined protrusion of a portion of the wall of the œsophagus. The size varies from a pea to that of a pear. They are pear-shaped or cylindrical, with an orifice considerably smaller than the circumference of the sac. The larger ones have a thick wall resembling on superficial examination the wall of the œsophagus. In the smaller ones the structure is that of a thin translucent pouch. In none of the typical pulsion diverticula do we find a complete muscular layer. The sac, even in the largest, is made up of mucous membrane covered by a layer of connective tissue. Near the neck of the sac there are found muscular bands which have been drawn down from the lower fibres of the inferior constrictor. Diverticula of the lower end of the œsophagus do not contain any muscular tissue. Those of the pharynx and the traction-pulsion diverticula may have a complete muscular layer. The mucous membrane rarely ulcerates, but frequently is thickened from papillary hypertrophy of submucosæ. Long-continued mechanical and chemical irritation, resulting from the retained ingesta, is sufficient to cause primary carcinoma of the diverticular wall. Cases in which carci-

noma was found are reported by Riebold, Quinset, and Grashius.

The symptoms occasioned by diverticula of the œsophagus are generally identical in the beginning with those of a gradually increasing stenosis which, at times, extends over a number of years. Most of those described have been in persons of advanced years, generally over fifty. In those in whom the dysphagia dated from early life, congenital stenosis probably occasioned the first symptom, to which later were superadded those of diverticulum. In Rokitansky's²⁵ case, in which the symptoms lasted for forty-nine years, the early difficulty in swallowing was probably due to an obstruction caused by the pressure exerted by a goitre. In the development of the diverticulum, as soon as the bulging mucous membrane is enlarged, so that a distinct sac is formed, the ingesta entering with each act of swallowing will be longer and longer detained, since the sac, being formed of mucous membrane alone, has no power of emptying itself, and will gradually enlarge from the pressure from within. The symptoms at first are usually only those of a slight stenosis. The more severe and characteristic symptoms begin when the sac is of sufficient size when full to compress the œsophagus and occlude its lumen, or by its weight to change the direction of the axis of the œsophagus, so that the orifice of the diverticulum is in direct line with the axis of the pharynx. The diverticulum now becomes filled at the beginning of a meal and compresses the œsophagus, preventing any food entering the stomach. Anything taken after this lodges in the pharynx and is soon thrown out again. In some cases, in the early stage of development, if the sac becomes filled, the food subsequently taken passes into the stomach unhindered. That contained in the sac is later ejected, establishing a condition simulating rumination. This symptom is quite characteristic of a diverticulum, although it also occurs in diffuse dilatation of the œsophagus.

In a case reported by Neukirch,²⁶ the patient was able to take food only when in the reclining position. In other cases the food lodged in the sac may remain many hours or days,

and can only be removed by pressure upon the neck or by contraction of the muscles of the neck, or by the act of vomiting. In case of deep-seated diverticula, food taken several days previously may be ejected from the sac, while that taken in the interval is not returned. The food which is ejected from the diverticulum is mixed with mucus and softened, but is never digested, nor does it contain any of the juices of the stomach.

In diverticula of the upper end of the Œsophagus the sac, which nearly constantly contains mucus and food débris, empties itself partially or wholly when the patient assumes the reclining position. The semifluid contents escape into the air-passages and bring on severe attacks of coughing or dyspnœa. A patient suffering from a diverticulum in this part of the Œsophagus soon learns that in order to secure rest he must empty the sac before going to bed.

Pain after eating is usually a symptom if the diverticulum is of sufficient size to cause obstruction by pressure. This pain usually continues until the sac is empty. It is deep-seated and retrosternal. In a case of diverticulum of the lower end of the Œsophagus reported by Jung,²⁷ the patient suffered from violent colicky pains in the epigastrium immediately after taking food of any kind. These pains were at first relieved by vomiting, but later were not. Pain of this character is more significant of spasm of the cardia than of a diverticulum. It must, however, be borne in mind that some deep-seated diverticula are associated with dilatation of the Œsophagus and spasm of the cardia. This second case reported by Jung, in which a violent cramp-like pain was also a prominent symptom, would appear to be of this nature. In diverticulum of the cervical portion of the Œsophagus a diffuse or circumscribed tumor of the neck, perceptible by inspection or palpation, may be an objective sign that permits of a positive diagnosis. Pressure upon this tumor will force food from the sac into the mouth and will cause the tumor to disappear. In cases where no tumor is recognized, pressure upon the neck behind the sternomastoid may empty the diverticulum and force its contents into the mouth.

The diagnosis of diverticulum of the œsophagus is based mostly upon the clinical history, the subjective symptoms above mentioned, and upon the evidence obtained by the use of the sound. The skiagraph may be employed with positive results in a few cases by filling the sac with bismuth mixture, or by introducing a metallic sound or rubber tube filled with shot. By this means the depth and position of the sac may be ascertained, which is of importance in deciding upon the advisability of an operation. In a diverticulum high up in the œsophagus, and in diverticula of the pharynx, the use of the œsophagoscope gives positive findings. In the deep-seated diverticula its value in making a diagnosis is slight. Transillumination has also been employed, but with limited success. In the sound we have a means of examination. if properly employed, that will permit of a nearly certain diagnosis. In many cases upon attempting to pass a moderate-sized or small sound we find it meets with an obstruction which first appears to occlude completely the œsophagus. Often in changing the position of the patient, as by throwing the head far back or to one side, the obstruction is easily overcome, and the sound passes into the stomach unhindered. In other cases, as in ours, we may not be able to pass a small or moderate-sized sound, while a large-sized sound will easily slip through. In still another class of cases, at certain times all sizes may be passed with ease, while at other times neither large nor small sounds can be introduced.

Rumpel²⁸ has made use of two stomach-tubes to differentiate between diverticulum and dilatation. This method, as improved by Jung, offers the best means, when carefully employed, of recognizing diverticula, particularly those of the lower end of the œsophagus. Rumpel employed two tubes,—one, with numerous perforations in its lower end, is passed directly into the stomach; the other, with but a single opening at the end, into the œsophagus above the cardia. Water, if poured through the second tube, will run down into the stomach through the opening in the first in case of dilatation. If a diverticulum exists, it will first be filled; and if the overflow will reach the stomach, the contents of the diverticulum can be returned to the second tube and measured.

The chief obstacle to this procedure is the introduction of the first tube into the stomach. In some cases of diverticula this is impossible, and in extreme cases of dilatation it is frequently difficult. Jung employs two tubes in the same manner as Rumpel. In addition, he introduces a third smaller tube, with only two perforations at the end, through the first or stomach-tube. By this means he is able to aspirate the fluid from the stomach, which gives positive information as to the position of the tube. With Rumpel's perforated tubes alone no fluid can be withdrawn from the stomach, thus making it impossible to ascertain definitely if the stomach has been entered. By allowing clear water to pass into the stomach through the first tube and a colored solution through the second, and by having the water returned unmixd with the colored solution from the inner or third tube, a positive diagnosis of diverticulum can be made, and dilatation of the œsophagus with or without cardia spasm can be excluded.

In non-malignant stricture of the œsophagus, if a sound be passed into the strictured zone, no mobility of the sound is possible; while in a diverticulum, if the sound be passed into the sac, although it cannot be pushed farther down, a considerable degree of lateral mobility is possible. This procedure is sufficient to differentiate simple stricture from diverticula.

The treatment of œsophageal diverticula may be either non-operative or operative. Of the latter, we have the palliative and the radical operations. The first case in which systematic efforts were made to cure the patient was treated by Dendy,²⁰ who attempted to obliterate the sac by injecting into it a strong solution of nitrate of silver. This proved disastrous, and has not since been attempted. In the persistent use of the sound- and stomach-tubes, we have the only means of palliative treatment worth considering. This method has, with more or less success, been practised by Berkhan,³⁰ Bruns,³¹ and Schede.³² In Berkhan's case the patient remained comparatively well for nineteen years. Neukirch was able to feed his patient through the stomach-tube by placing him on the right side in a reclining position. After the use of sounds and tube

for some time, the symptoms greatly improved. Waldenberg³³ and Schede employed a faradic current applied to the œsophagus near the orifice of the sac and to the diverticular wall, with improvement in the general condition of the patient and diminution in the size of the sac. In Schede's case the sac shortened three centimetres in four years. Although temporary relief may be had in a few cases by the use of the sound, this method of treatment is not free from danger, and can be employed only in a few cases, because of the difficulty in introducing the sound. The chief danger is perforation, which can readily occur, owing to the extremely thin wall of the sac and to the act of vomiting which the presence of the sound may excite. A fatal perforation from the use of the sound occurred in the practice of Bruns.

The palliative operation of gastrostomy designed to relieve the symptoms, or rather to prevent death from starvation, was first practised in 1877 by Shönborn.³⁴ The same method was employed by Whitehead,³⁵ Koenig,³⁶ and Chavasse.³⁷ This operation is only indicated where there is no possibility of removing the sac, as in deep-seated diverticula, or where the patient's condition is such as to preclude the possibility of a successful radical operation.

The method of treatment of diverticula by excision of the sac was first suggested by Klüge³⁸ in 1864. The first to attempt removal of the sac was Nicoladoni. He did not succeed, but opened the sac and sutured it to the skin. Death from pneumonia followed on the eighth day. Bergmann³⁹ in 1890 performed the first successful excision of the sac. In 1900 Veiel⁴⁰ was able to collect twenty-three cases operated on, including one of his own. Of these five died and eighteen recovered. The causes of death assigned were suppression of urine, diarrhœa, bronchopneumonia, and erosion of the superior thyroid artery. In one case the autopsy did not reveal the cause of death.

The technique of the operation for incision of the sac is, with slight modifications, the one first suggested by Hamburger⁴¹ in 1871, several years before the first operation was

performed. In all of the cases operated on a skin incision was made along the anterior border of the sternomastoid muscle; by dull dissection the œsophagus is reached. No vessels of any importance are encountered excepting the superior thyroid vein. In one case the superior and second inferior thyroid arteries were ligated. The normal thyroid gland can be drawn aside and is not in the way. In a case in which the thyroid was enlarged, Bruns found it necessary to remove the lateral lobe in order to reach the diverticulum. The sac has been removed both by cutting and by thermocautery. The latter method has not given good results. The necrosis following its use prevents speedy union of the cut edges. The most important step in the operation is the closure of the opening in the œsophagus. At the present time nearly all operators advocate the immediate closure of the opening by sutures, although Bergmann believes it scarcely possible to secure primary union.

Various methods of suturing the œsophageal opening have been employed. It would appear that the most satisfactory result would be obtained by first passing around the neck of the sac a purse-string suture. Second, distal to this temporary ligature of the neck of the sac. Third, abscission of the sac beyond the ligature. Fourth, invagination of the stump, and tying the purse-string suture. Fifth, suture of the neck of the sac with catgut, using the Lembert suture. Sixth, closing the defects in the muscular wall of the œsophagus by suture, preferably of silk.

Berger⁴² only partially closed the opening by suture and introduced a stomach-tube. This procedure is not to be considered, as the presence of the tube in the œsophagus induces vomiting and subsequent leakage, with certain infection of the wound. Several operators, among them Richardson, Bruns, and Kocher,⁴³ have succeeded in obtaining primary union of the whole operation wound. In two cases a preliminary gastrotomy has been performed in order to nourish the patient during the course of the healing of the wound. Girard,⁴⁴ in 1895, devised an operation for the radical cure of diverticulum of the œsophagus by invaginating the sac into the œsophagus and

closing the defect in the muscular wall of the œsophagus by suturing. He operated on two patients by this method. In one the result was ideal; in the other a fistula followed, which later closed. By this method the œsophagus is not opened, and therefore the risk of infection is but slight. It can only be employed when the sac is of small size, and when the lumen of the œsophagus below the neck of the diverticulum is of normal size.

The following case was referred to me by Dr. J. E. Best, of Arlington Heights, Illinois, and treated by this method.

Mr. W., aged seventy-six years. Present trouble began seventeen years ago, with difficulty in swallowing solid food. For a number of years this was the only trouble experienced, excepting that sometimes after meals food swallowed during the first part of the meal would be returned to the mouth and again swallowed. He also noted that the first food taken appeared to lodge in the upper part of the throat, at a point apparently just below the larynx. As the years passed the symptoms of obstruction became more pronounced, so that about two years ago it became impossible for him to take solid food of any kind. Since that he has been forced to subsist upon liquids, which have been taken with increasing difficulty up to the present time. A few months ago he noted that liquids taken while in the reclining position seemed to be swallowed with less difficulty and to remain in the stomach. At the present time, anything taken while in the upright position is immediately regurgitated. During the last few months he has rapidly lost flesh and strength, and employs most of his time in endeavoring to swallow sufficient liquid nourishment to maintain life. This is accomplished by taking a few drops at a time. After taking food, there is considerable pain, which is referred to the neck above the upper border of the sternum. This pain is relieved by vomiting or by compression of the sides of the neck with the hands, which forces the food previously taken into the mouth. At no time has any blood been vomited.

Examination.—There is a considerable degree of emaciation; chest and abdomen negative. No enlargement of cervical glands. No tumor can be seen or palpated in the neck. On giving water to drink, a small quantity, about thirty cubic centi-

metres, is retained. Any taken after this is regurgitated. Pressure upon the neck made below the larynx and behind the sternomastoid muscles will force the water previously taken back into the mouth. At times, without drinking water, a quantity of mucus can be forcibly thrown into the mouth by pressure made in the same way. If the mouth is opened and sudden pressure made, as described, the mucus or water may be forced from the mouth.

On attempting to pass a small-sized (1.25 centimetres) olive-tipped bougie, there is an obstruction met just behind the larynx at a distance of seventeen and three-quarters centimetres from the incisor teeth. Below this point the bougie cannot be passed, but it can be moved from side to side for some distance. At the time of the first examination, no bougie could be made to pass this point. At a later examination a larger-sized tip (two and one-half centimetres) was employed, and this passed readily down into the œsophagus. At times this large-sized bougie could be introduced without any difficulty; at other times it could not be made to enter farther than a distance of seventeen and three-quarters centimetres. At no time could the ordinary stomach-tube be made to pass into the stomach.

The patient was given a bismuth mixture to drink, and a radiograph of the neck was taken. A fairly distinct shadow was to be seen just in front of the vertebra, and about half-way between the larynx, which was ossified, and the upper border of the sternum. Upon the history and the findings described, a diagnosis of a pulsion diverticulum at the pharyngo-œsophageal junction was made. On January 8, 1903, under chloroform anaesthesia, the patient was operated upon at the Chicago Polyclinic Hospital, Dr. Paul O. Owsley assisting.

An incision was made on the left side from the angle of the jaw to the sternoclavicular articulation anterior to the sternomastoid muscle. The superior thyroid veins and artery were divided between ligatures. Dull dissection through a perfectly dry field readily exposed the œsophagus. There was some difficulty experienced in locating the diverticulum. This was overcome by passing a bougie through the mouth into the pouch. By this means the diverticulum was lifted from its bed and brought to the side of the œsophagus. The diverticulum was pear-shaped and measured four centimetres in length and three

in width. It lay slightly to the left and behind the œsophagus. The neck of the sac was a trifle below the lower border of the cricoid cartilage. The sac was very thin and translucent. With the bougie in the œsophagus the mechanism of the obstruction caused by the diverticulum could be demonstrated. The lower border of the neck of the diverticulum acted as a valve, projecting into the lumen of the œsophagus. Upon introduction of the sound, it came in contact with this valve-like projection, which, upon further pressure, was forced down and completely obstructed the œsophagus, and directed the sound into the diverticulum.

The sac was readily freed from its attachments to the surrounding tissue. A purse-string suture of catgut was passed around the neck with the sound in the sac. The sound was then withdrawn and the sac inverted, and at the same time invaginated into the lumen of the œsophagus. The purse-string suture was then tied. Three sutures of catgut were then passed through the neck of the inverted sac. These did not penetrate into the lumen of the diverticulum. Over these sutures, the longitudinal muscular layer of the œsophagus was united by interrupted catgut sutures. A third layer of chromicized catgut sutures transverse to these was introduced. By the latter the inferior constrictor of the pharynx was brought down, covering the first sutures. A large-sized bougie could be passed without difficulty into the stomach.

The skin wound was closed without drainage. For five days the patient was nourished by nutritive enemata. After this he was allowed milk, which he swallowed without difficulty. At the end of two weeks he left the hospital. Upon reaching home he ate heartily of solid food. Following this he suffered from a severe attack of acute gastritis, for which he was treated by Dr. Best, and from which he recovered. Since the operation he has not experienced any difficulty in swallowing any kind of food.

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